



Fermilab

TM-788
1600.00

HELIUM PROPERTIES SUBROUTINE

M.Kuchnir

April 20, 1978

A subroutine containing thermophysical properties of He⁴ is now available in the PDP-10. Its authors are unknown to me. I obtained a copy of it third-hand and modified it to run in our time-sharing system. My driver program HEPROP.F4 allows one to use it as a table for 17 properties. I have been comparing its results with NBS Technical Note 631¹, and found them quite acceptable, but I suggest that you check their range of validity and deviation before blind usage. The Fortran source program is implemented with comments. You may copy them to your Disk area by using:

```
. R PIP <CR>
* *.* /X = [177,557]HEPROP.F4,HE4.REL <CR>
* ↑C
```

In a Fortran program the subroutine is called with the statement:

```
CALL HELIUM (I,P,T,VAL)
```

where P is the pressure in atmospheres, T the temperature in Kelvin. The code number for the property, I, and the resulting value, VAL, are given according to the table:

<u>I</u>	<u>VAL</u>	<u>UNIT</u>
1	MELTING PRESSURE	ATM
2	LAMBDA PRESSURE	ATM
3	VAPOR PRESSURE	ATM
4	DENSITY	MOLES/LITER
5	SPECIFIC VOLUME	LITERS/MOLE
6	VISCOSITY	G/CM-SEC.
7	DP/DD	ATM/(MOLES/LITER)
8	DP/DT	ATM/DEG.K
9	INTERNAL ENERGY	JOULES/MOLE
10	ENTHALPY	JOULES/MOLE
11	ENTROPY	JOULES/MOLE-K
12	CV	JOULES/MOLE-K
13	CP	JOULES/MOLE-K
14	SPEED OF SOUND	METERS/SEC.
15	COMPRESSIBILITY	1/ATM
16	EXPANSIVITY	1/DEG.K
17	THERMAL CONDUCTIVITY	mW/CM-K

The driver program HEPROP.F4 is run with:

. EXEC HEPROP,HE4

After typing the code table, the program prompts the operator to provide values of temperature (K), pressure (atm) and code number (a sequence of three numbers separated by spaces or commas and followed by <CR>). The program then returns the result in more convenient units* and another prompt. The input parameters can then be reduced to one (just T) or two (T and P), the missing ones being defaulted to their previous values, and prompting skipped for more expedient operation. Prompting resumes after a three parameter input. A negative P or I or a nonnumerical character in the input terminates execution.

I would appreciate receiving feedback on the performance of this subroutine.

1. R.D.McCarty, Thermophysical Properties of Helium-4 from 2 to 1500K with Pressures to 1000 Atmospheres, Technical Note 631, National Bureau of Standards (1972).

*HEPROP converts mole-based units to gram-based units

(1 mole He⁴ = 4.00 g). For programming expediency the unit of viscosity, micropoise, is represented by UP and the unit of thermal conductivity, $\mu\text{W}/(\text{cm.K})$, is represented by U/CMK.